Towards a cleaner surrounding for electron spin qubit in III-V semiconductors

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Abstract:

A single electron spin localized in III-V semiconductor structure is an attractive candidate for a solid state quantum bit. An outstanding bottleneck towards spin-based quantum computation has been the fast dephasing of the electron spin by the inevitable nuclear spin environment. In this talk, I will discuss preparations of nuclear spin environment using optical and electrical controlled dynamic nuclear spin polarization to substantially increase the electron spin dephasing time [1,2]. I will also introduce a novel approach to squeeze the nuclear spin bath into many-body singlets, where the deleterious environmental moments are effectively annihilated. The large scale entanglement in many-body singlets may also become a useful resource for nuclear spin based information processing.

References:

[1] Xiaodong Xu, Wang Yao, Bo Sun, D. G. Steel, A. S. Bracker, D. Gammon and L. J. Sham, Optically controlled locking of the nuclear field via coherent dark-state spectroscopy, Nature 459, 1105 (2009).

[2] Wang Yao and Yu Luo, Feedback control of nuclear hyperfine fields in double quantum dot, To appear in Europhys. Lett.

[3] Wang Yao, Many-body singlets by dynamic spin polarization, to be submitted.